Gizmo's Counting Board

Being a device to teach decimal and binary counting to young learners.
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I. How to make Gizmo's Counting Board

In making the counting board please refer to the attached pictures.

A. Make the back piece, 14" by 8 ½" and paint one surface white

B. Make 2 buttress pieces 6" across. In each of these drill 7 holes, 1/8" in diameter and ½" deep. Start at the center and then space the holes at ¾" intervals, moving out from the center, 3 on each side.

C. Make some 7 metal rods 11 ½" by straightening some coat hangers.

D. In one of the buttresses glue one end of each metal rod into a hole. Epoxy is preferred but a small amount of other glue is acceptable. Let the glue cure.

E. On the back, affix with glue or by screws on the reverse, the buttress without the glued-in wires.

F. With a permanent marker, draw and number the 9 cross lines as shown in the picture. The lines will ultimately lie under the middle of each row of beads. Depict the zero row at the level of the buttress itself—it will have no row of beads under it.

G. Thread on each metal rod 9 beads.

H. Insert the free end of each metal rod into the corresponding hole in the buttress already affixed to the back piece.

I. Secure the buttress with the glued in the metal rods onto the back piece using glue or by screws from the reverse side.

J. Number the 7 columns on the upper buttress with the appropriate decimal powers.

K. Screw in some screws into the top of the upper buttress and cut off the head so that the screw becomes a little metal peg that sticks out.

L. Make a 7" x 6 ½" x 1/8 " board. Drill two holes in its 6 ½" length to fit the metal pegs in the upper buttress.

M. Glue a lip onto the lower 6 ½" length perpendicular to it so that it rests on the metal rods and forms a stop for the beads. If you want you can file 7 indentations into this lip to fit over the metal rods.

N. Fit the 7x6½ board on the metal pegs and then write the appropriate binary powers over each metal rod.

O. Cut a sheet of white paper to cover the numbers and lines written on the back piece when using the binary cover piece.

II. How to use Gizmo's Counting Board. Decimal.

A. Slide all the beads to their upper position. Count aloud while moving a bead, starting from 0, then 1, 2, 3... Go to over 100. Count backwards making sure to move the beads properly when a 0 place-holder is encountered, but optimally the student should figure this out herself. Count up by 2s, 3s. 4s. 5s. Count backwards by 2s, 3s, 4s, 5s, etc.

B. Slide all the beads to their upper position. Represent various numbers using the beads. After each number is represented, slide all the beads to their upper position. Start with small numbers, but continue to numbers over a million. Be sure to include many numbers in which 0 is used a placeholder, for example, 1230485.

C. Slide all the beads to their upper position. Let the teacher of student's partner make some arbitrary bead arrangements. Then let the student write the number that the arrangement represents.

D. Slide all the beads to their upper position. Add numbers. Start with single digit numbers first. Slide the beads for the first number in the one's column. Then add a bead at a time to that number. When 9 beads are used up in the one's column, the next movement will be to slide them all up and slide down a bead in the 10's column. Continue adding by resuming the count in the one's column, sliding a bead each time.

E. Slide all the beads to their upper position. The teacher of partner will represent a larger number with the beads. The student will then subtract the lesser number. This should be done by referring to the numbers written down on a piece of paper. Work as usual, beginning with the 1's column. If 10 needs to be borrowed, slide a bead up from the 10's column to signify that a 10 was borrowed. Proceed to the next column to the left.

F. Advanced. Multiplication can be demonstrated as iterative procedures of addition. Division can be demonstrated. Use the usual algorithms on paper and refer them to the counting board representations. Above each decimal column can be written the appropriate power of 10 representation.

III. How to use Gizmo's Counting Board. Binary

A. Slide eight beads on each rod to their upper position. Attach the 7x6½ board to the upper buttress, leaving one bead to be slid on each rod in the working area. Put the piece of white paper over the decimal grid so that only the "1" row shows. There should be only one bead per rods showing and capable of being slid back and forth.

B. Slide all the beads to their upper position against the lip of the binary cover piece. Count aloud saying the usual name for the number, sliding a bead each time. As you count up, change column appropriately. At the beginning you will be switching columns a lot, but that is correct. Count backwards. Count up by 2s. The student should notice that the 1s bead never moves. Count up by 4s. Counting up by 3's is difficult and needs to be referred each time a 3 is added. Nevertheless, an alternating pattern emerges for the movement of the beads.

C. Double up. Start with 1 and double the number each time. You can go up to 64. Once at 64, halve each number. Have the student notice how the beads move, one column at a time.

D. Add two numbers. Start with a number, say 10. Now count up one at a time until the other number, say 7, is reached, moving the beads one at a time. Check the count each time, making sure not to skip any columns. Addition is just iterative counting, even in binary.

E. Multiplication as iterative additions.

F. Very Advanced.

IV. Certain advantages of teaching number systems using Gizmo's Counting Board.

A. Process. Demonstrates the similar processes common to the decimal and binary number systems. Allows the student to discover these processes. Demonstrates algorithms of counting by units, 2s, 3s, etc. and adding in both systems. The algorithms are slightly different between the two systems, which the student can discover by herself. Subtraction yields still different processes.

B. Patterns. The student is allowed to discover the patterns that the beads take in counting and addition. The different patterns relate to the algorithms of counting and adding, and similarly for subtraction.

C. Tactile learning. Combine tactile learning with audile and visual. This cannot be had using a similar system on a digital screen.

D. Relates the symbolic visual and verbal processes of counting and addition to the concrete and tactile processes involving the movement of the beads.

E. Relates different counting systems, the decimal ones we use and the binary ones we use. It is designed for 3rd to 6th graders and thus presents the binary system early on. I hope that it will be proved to be useful and if so, then incorporated into the set of best practices for teaching mathematics